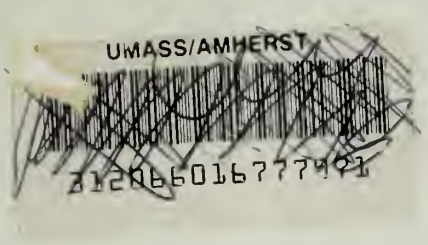

Cancer in South Hadley, Chicopee and Holyoke, Massachusetts: An Analysis of Incidence and Mortality Data.

Massachusetts Department of Public Health

Division of Environmental Epidemiology and Toxicology

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EXECUTIVE SUMMARY

This descriptive study of cancer incidence and mortality was initiated by the Massachusetts Department of Public Health (DPH) in response to citizen concern over elevated cancer rates in the town of South Hadley. Additional concern was voiced regarding the possible relationship of cancer with emissions from the James River Graphics (JRG) plant located in South Hadley.

The cancers investigated were lung, urinary bladder, prostate, female reproductive organs (uterus and ovaries), breast, and leukemia. At the suggestion of the South Hadley health agent the study was expanded to include Chicopee and Holyoke due to their close proximity to the JRG plant.

South Hadley, Chicopee and Holyoke are in the Connecticut river valley north of the City of Springfield in Western Massachusetts. The older sections of Chicopee and Holyoke and the southwest part of South Hadley along the Connecticut river are fairly densely populated and have long been industrialized. Manufacturing has been the predominant economic pursuit with the manufacture of paper and plastic coating materials, and the process of paper coating comprising the major industries. Historically, the ambient air in the area is very likely to have been polluted by toxic emissions from industrial plants, but reliable historical data on air pollution are not available. There is no evidence to suggest significant pollution of soil or drinking water in the area.

Existing data on cancer and personal characteristics (i.e. age, sex, smoking status, occupation, etc.) supplied by the Massachusetts Cancer Registry and the Registry of Vital Records and Statistics were utilized

for this investigation. Cancer incidence data were analyzed for the period 1982-84 while cancer mortality data analyses covered the period 1969-85. Analyses were also conducted according to census tract in the event that geographical clustering might indicate specific high risk areas within each city or town. The occurrence of cancer in each town and in each census tract within the towns was compared to that observed statewide for Massachusetts.

The data suggest that, in comparison to the State as a whole, a greater risk of certain types of cancer may exist in the three towns. Appendix D shows the types of cancers with greater than expected mortality and incidence. These include leukemia and cancer of the bladder, prostate and female reproductive organs among South Hadley residents; leukemia and cancer of the bladder and lung among Chicopee residents; cancer of the prostate among Holyoke residents. It is important to note that most of the elevations are based upon small numbers of cases for which meaningful interpretations regarding the risk of cancer cannot be made. However, the most notable and consistent findings are the elevations in mortality from prostate cancer among South Hadley and Holyoke males and the elevations in bladder cancer mortality and incidence among South Hadley and Chicopee males and females.

When the date were analyzed by census tract, the areas that appeared to show the most consistently elevated risk of cancer were the tracts bordering the Connecticut River. Specifically, tract 8213 in South Hadley and the four tracts in the vicinity of the JRG (census tracts 8113, 8114, 8117, 8211). The JRG area showed higher than expected bladder and prostate cancer mortality. There was excess risk of prostate cancer and leukemia mortality among males in tract 8213.

In the absence of historical data on air pollution and emissions from

industrial plants in the area, a causal relationship between air pollution, the presence of industry and the risk of cancer cannot be established. However, the nature of the industry that has existed in the area and the local topography suggest that significant air pollution may have been possible. This might partly explain the excess risk of cancer observed in the area. It is not possible, though, to conclude that any particular industry or type of exposure has resulted in the excess cancers. The chemical pollutants that might have been responsible for the excess risk cannot be identified from the many chemicals that likely constitute the air pollution, which probably originated from a number of sources.

The findings of this investigation, though, are not totally consistent with those expected if exposures in the general environment were related to the increased risk of cancer. Some of the elevated cancers such as prostate and female reproductive organ cancers are not generally known to be caused by environmental exposures. Dietary fat intake and hormonal factors are the principal risk factors for these cancers. Additionally, lung cancer, which can possibly be caused by exposure to air pollution, was not in excess in the vicinity of JRG and was usually not in excess elsewhere in the towns. These findings suggest that risk factors other than air pollution may be responsible for at least some of the observed excess cancer risks. These risk factors may include occupational exposures, which are likely higher than exposures to the same chemicals in the general environment. The main risk factor for bladder cancer is cigarette smoking but certain chemicals may also cause bladder cancer. Some of the industry in the towns may have used these suspected bladder cancer carcinogens. There is usually no exposure to these chemicals in the general environment. However, excess cancer can be observed to be

localized in specific census tracts as a result of similar occupational exposures, just as can be observed from environmental exposures.

While the results of this investigation suggest that more cancer of certain types was observed than expected, it cannot be concluded that the residents of the towns today are at high risk for developing cancer. Incidence, which is the best indicator of the current risk of cancer in the area, shows that only bladder cancer among Chicopee males and cancer of the reproductive organs among South Hadley females are significantly elevated. Furthermore, the exposure(s) which caused the cancers presented in this report generally occurred between fifteen and forty years before the time of diagnosis of cancer or death. With the passage of environmental laws, improved pollution control measures, and reductions in exposures at the workplace in recent years, the risk of developing cancer from exposures today may be quite different than that existing twenty years ago. The risk of cancer among long-term residents of the area, though, cannot be determined, nor can the risk among new residents be estimated. The assessment of the magnitude of public risk or the establishment of a cause and effect relationship between exposure to air pollution and cancer is precluded by the limitations in the data available for this investigation. Therefore, to attempt to minimize the risk of cancer in the communities and to more fully and precisely characterize the individuals who may be at higher risk for cancer, DPH recommends the following;

(1) DPH collaborate with citizens, local and regional health agencies and the medical community to implement a program of health education/health promotion directed toward primary and secondary prevention of cancer.

(2) DPH coordinate efforts with the Division of Occupational Hygiene to attempt to identify and control occupational exposures within the three town area.

(3) DPH coordinate efforts with the Department of Environmental Quality Engineering in order to identify and control sources of air pollution and review engineering controls at industrial plants emitting large quantities of air pollutants in the area.

(4) DPH conduct a study of bladder cancer, when resources become available, in order to obtain occupational and residential histories as well as additional information.

INTRODUCTION

The main purpose of this investigation was to assess cancer incidence and mortality in South Hadley, Holyoke, and Chicopee. This project was initiated in 1984 because a resident of South Hadley and the South Hadley Health Agent requested that the Department of Public Health (DPH) investigate cancer incidence and mortality in South Hadley. Excessive risk of cancer was suspected among the residents of the town. There were also complaints about emissions from James River Graphics (JRG), a large paper coating plant located along the Connecticut River in an area of South Hadley bordering Chicopee and Holyoke (figure 1). These emissions were suspected of being a possible cause of cancer in the area.

This report presents an analysis of cancer incidence and mortality data for South Hadley, Chicopee, and Holyoke. The scope of the original project was expanded to include Chicopee and Holyoke because the JRG plant is located close to the boundaries of Chicopee and Holyoke.

Environmental History

South Hadley, Chicopee and Holyoke are located in the Connecticut river valley north of the City of Springfield in Western Massachusetts. The population of South Hadley is approximately 17,000. Chicopee and Holyoke have much larger populations, approximately 50,000 people live in each town. Manufacturing is the predominant economic pursuit in the three towns. Major industries this century have been the manufacture of

paper and plastic coating materials and the process of coating, with the current industrial emphasis in the three towns largely devoted to various coating operations. Other manufacturing processes in the three towns have been leather tanning, printing and publishing, and match making, as well as the production of chemical products, primary metal and metal products, electric and electronic equipment and sporting goods. The number and variety of materials used and made by industry in the three towns is quite extensive.

There are no major hazardous waste sites in South Hadley, Chicopee, or Holyoke known to the Department of Environmental Quality Engineering (DEQE). The public water supply for the three towns comes from different sources. Chicopee's source of drinking water is the Quabbin Reservoir (surface water source). South Hadley, has three different sources - the Quabbin Reservoir, one groundwater well, and a surface water source called Elmer Brook. Holyoke has both groundwater and surface water sources for their drinking water. The groundwater sources are the Cornet and Pequot wells, while the surface water sources are the Whiting Street, Hugh McClean and Manaham Reservoirs, and the Wright-Ashley Ponds. For at least 15-20 years none of these supplies have had contamination problems that required their closure. The major water quality issue in these three towns is corrosivity in the Holyoke supply that might lead to elevated levels of certain metals, but would not involve any organic compounds.

Routine testing conducted on drinking water supplies in the Commonwealth of Massachusetts depends on the source of water, i.e., from surface or groundwater Surface waters sources are tested more frequently than groundwater sources with all supplies being tested for

certain routine parameters, such as pH, turbidity, coliform bacteria, iron, hardness, nitrates, and color. In addition, groundwater supplies are tested about once every three years for a group of volatile organic compounds (VOCs) that include tricholoroethylene, tetrachloroethylene, benzene, toluene, and chloroethane. If a water supply is chlorinated, it is tested at least annually for trihalomethanes (THMs), which occur in chlorinated water. In all three towns, only the surface water sources are chlorinated and therefore, only these sources are tested for THMs. In addition, these supplies have been tested for other inorganics, such as chromium, arsenic, and cadmium, as well as certain pesticides, such as alachlor, aldicarb, EDB, and others.

Since the passage of the Clean Air Act in 1970, DEQE routinely monitors ambient air statewide for the criteria pollutants, i.e., sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Meteorological parameters measured include wind speed, wind direction, and temperature. South Hadley, Chicopee, and Holyoke are located within the Pioneer Valley Air Quality Control Region and there are a number of monitoring locations within these towns, i.e., four in Holyoke, two in Chicopee, and two in South Hadley. Since DEQE began monitoring air quality, no where in Massachusetts were any of the criteria pollutant standards exceeded with the exception of ozone which is a respiratory irritant. In 1985 the 0.125 parts per million standard was exceeded at thirteen of the fourteen ozone monitoring stations statewide. The maximum ozone value (0.198 ppm) was recorded at Chicopee. Although none of the other National Ambient Air Quality Standards were exceeded, it was noted that the highest annual average (37 ug/m^3) of sulfur dioxide

was in the Springfield area.

It is likely that the most significant sources of current exposure to the population of these towns may be from chemicals emitted to the ambient air from industrial sources. There are presently thirteen industrial sources which emit greater than 10 tons per year of volatile organic compounds into the air. Historical information on volatile organic emissions (See Appendix A) is available only from DEQE beginning in 1980. A list of industries in the three towns in 1943 and in 1970 is given in Appendix B. In most cases, specifics on the types of compounds emitted are not available for past years. There has been considerable variation over time in the quantities emitted considering that some major emitters (greater than 100 tons per year) are no longer operating. While DEQE's detailed source inventory will have great value for the future, good historical information is very difficult to reconstruct.

In the 1940's, printing, coating of plastic products, metal working, and manufacturing of paper, plastic products and machinery were the predominant industries. A review of current literature on occupational exposures indicates that workers at that time might have been occupationally exposed to the following hazards listed by industry:

Printing

Exposures can vary widely, but generally include: solvents (i.e. tri- and tetrachlorethylene, benzene, ethylene glycol, ethers, toluene, methyl

ethyl ketone and others); corrosives; chromates and other heavy metal pigments; glues; gums; aniline dyes; and various inks.

Some of these substances (e.g. solvents, corrosives, gums, etc.) are associated with dermatoses and respiratory irritation. Others are known as suspected carcinogens (e.g. benzene, tri- and tetrachloro-ethylene, chromates, aniline dyes and benzidine based organic pigments.

Paper Manufacturing

Exposures among workers in the paper manufacturing industry are similar to those of workers involved in the printing industry. The most common industrial exposures include: anti-flameagents; dyes; glues (natural and resin); mildew proofers, and waxes.

The substances that are most likely to be carcinogenic would be some of the dyes used in this industry. Some of these dyes (auramine and fuchsine or magenta, in particular) have been associated with the incidence of bladder cancer among workers that were occupationally exposed.

Metalworking and Machinery Manufacturing

Exposures in these industries include: corrosives used in treating metal from lead baths and ovens; and, from solvents used to clean metal parts. Most of the hazards associated with the above processes are

accidental and physical hazards, lead and other heavy metal exposures, or solvent exposures from degreasing operations. Exposures to heavy metals, such as arsenic, lead and cadmium, have been associated with increased rates of cancer of the lung. Other exposures to carcinogens most likely occur in vapor degreasing operations. Because of recent improvements in technology and more stringent regulation of vapor degreasers, more recent exposures are probably lower than in previous decades.

Plastic Product Manufacturing and Coating

Plastics manufacture utilizes hundreds of raw materials. These are then processed into various polymers with the addition of additives, accelerators, stabilizers, antioxidants, fillers, pigments, and plasticizers. Some examples of different types of resins are: acrylic resins; alkyd resins; isocyanates; melamine; phenolic and amino resins; polyacrylonitrile fibers; polyamides; polyester resins; polyfluorines; polyolefins; polyproprylene; polystyrene; synthetic rubber; and polyvinyl chloride. Substantial exposures to solvents may occur in plastic coating operations because of the large surface area coated and the large volume of solvent used. While many of the pigments and colorants described above may be found in plastics they are bound up in the plastic mixture and may not be as likely to cause as serious exposure as in their pure form. This would not be true during mixing/formulating operations during which carcinogenic colorants might be used in their raw form.

Some examples of carcinogenic substances historically found in

plastics operations are: ethylene thiourea (accelerator for polychloroprene), various benzidine-derived dyes (textile, paper, and leather goods), various chloroethane solvents, various vinyl halides, epichlorohydrin (catalyst for epoxy resins), chloroprene (intermediate in synthetic rubber), chrome pigments, beta-naphthylamine and phenyl-beta-naphthylamine (antioxidant in synthetic rubber), 2-nitropropane (solvent for coatings and printing inks), and acrylonitrile (monomer for various plastics).

Since there is no evidence to suggest that drinking water or soil in the three towns is significantly polluted, and since historical data on industrial emissions or possible pollution of ambient air were not available, this investigation was not designed to determine the relationship of the risk of cancer in the three towns with past general environmental pollution or the presence and location of manufacturing industries in the area. Rather the main purpose was to assess cancer incidence and mortality in the three towns in comparison with a standard population.

METHODS

Existing data on cancer available to DPH were used for this investigation. Cancer mortality data for the three towns came from the Massachusetts Death Registry and incidence data for the towns from the Massachusetts Cancer Registry which are both administered by DPH. Mortality data for the years 1969-85 were used in the analysis because mortality prior to 1969 has not been computerized. Cancer incidence data used in the analysis were for the 1982-84 period because the Cancer Registry only began in 1982 and complete data for 1985 were not available for analysis.

A preliminary analysis of cancer incidence (1982-83) and mortality (1969-83) data suggested that the risk of lung cancer among women and cancer of the prostate gland in men might be higher in South Hadley than in the State of Massachusetts. Relatively high risks of cancers of the urinary bladder, breast, and female reproductive organs, and of leukemia were also suspected. Consequently, cancers of all these sites were included in the analysis.

Cancer incidence and mortality in South Hadley, Chicopee and Holyoke were described according to census tracts (CT) so that high risk areas within each town could be identified. Since Westover Airforce Base and Mount Holyoke College occupy the whole of tracts 8105 and 8212, respectively, these two CTs were excluded from the analysis. The rate of occurrence of each cancer type in each CT was compared with the corresponding rate in the State of Massachusetts taken as a whole. To

compare the risk of cancer in the town with that in Massachusetts, the data for all CTs in each town were pooled. Since the location of the JRG plant in South Hadley was a cause for concern, the data for CTs 8211, 8113, 8114, and 8117 surrounding the JRG plant were also pooled together to compare the risk of cancer in this area with that in Massachusetts. The comparisons of incidence were carried out separately from those of mortality. Cancer mortality comparisons were carried out for the entire 1969-85 period and for the 1969-74, 1975-79 and 1980-85 time intervals.

In order to assign cancer deaths and incidence cases to each CT in the three towns, residential addresses of the cases were abstracted from death certificates and cancer (incidence) notification records. Street maps of the three towns were used to locate the addresses in the CTs.

Since cancer is an age related disease, in comparing rates, appropriate adjustments were made for differences in the age distributions of the populations of each CT and the population of the State of Massachusetts. The indirect method of standardization was used. According to this method, age-sex-time-specific rates for the State of Massachusetts were applied to the age distribution of each CT to estimate the expected numbers of cancer deaths/incident cases. The expected number of deaths from a cause in a CT are, therefore, the number of deaths to be expected in a time period if the population of the CT experienced the same risk of mortality as the population of the state. The expected number of incident cases are interpreted the same way. The 1970 and 1980 census data were used to determine the age-sex distributions of the CT populations for the 1969-74 and the 1980-85 periods respectively. For the 1975-79 time period, age distributions in 1977 (estimated from 1970 and

1980 census data) were used.

The number of deaths from a cancer observed in a time period in a CT were compared with the (estimated) number of deaths from the cause expected in the same time period and CT. The ratio of the two numbers (observed number divided by the expected number) is the standardized mortality ratio (SMR). Likewise, the ratio of observed and expected incident cases of a cancer, for a specific time period and CT, is the standardized incidence ratio (SIR). A ratio of 1.0 indicates no difference in the risk of cancer between the populations of the CT and the state. A value greater than 1.0 indicates a greater risk exists in the CT than in the state, while a value less than 1.0 indicates a greater risk in the state than in the CT.

The statistical significance of the difference between the observed and the expected number of events were determined using methods appropriate for the number of observed events (deaths or incident cases). Exact one-sided p-values were computed assuming a Poisson distribution for 5 to 20 events. For observed events greater than 20, one-sided p-values were computed assuming an approximate Normal distribution. Statistical significance was not determined for very small numbers of observed events (less than 5 events) because the numbers are too small to make meaningful interpretations.

The p-value for a ratio indicates the probability (p) of the difference between the observed and the expected events to have occurred by chance. In interpreting the SMRs and SIRs in this investigation, statistical significance was assessed at the traditional 0.05 level. If the p-value for a ratio was less than 0.05, the difference between the observed and expected events was described as statistically significant.

This indicates that there is only a 5 percent or less probability that the difference between the number of observed and expected events could have occurred by chance. Conversely, if the p-value was equal to or greater than 0.05, the difference was described as statistically not significant, because there was a greater than 5 percent chance that the difference was due to chance.

In order to assess personal factors that are often associated with environmental cancers, histories of cigarette smoking and usual occupation of the (incident) cancer cases in the three towns were obtained from the Massachusetts Cancer Registry. These data are abstracted by hospitals and supplied to the Cancer Registry. Smoking status is classed as current smoker, ex-smoker, or non-smoker. If the usual occupation of a case was not recorded in the medical records, the hospital supplied the current (at the time of the medical record) occupation as stated by the patient. Occupations were aggregated by the major industrial groups. Smoking history was obtained for cases of lung and bladder cancers (the cancers of interest known to be associated with cigarette smoking) and for cases of colo-rectal cancer, a comparison group (colo-rectal cancer is not associated with smoking). Occupational history was obtained for cases of lung cancer, bladder cancer, and colo-rectal cancer.

For the purpose of comparison with cancer cases, the data on smoking status from the 1986 Massachusetts Health Interview Survey conducted by DPH were also examined. A sample of approximately 6,800 men and women aged 18 or older was drawn from the residents of Massachusetts. The sample was weighted to include larger numbers of black and Hispanic residents so that racial comparisons could be made. Approximately 55% of the sample participated in the survey.

RESULTS

Mortality

Cancer mortality data for the three towns are described according to CT in Tables 1-24. Tables 1-8 deal with mortality in South Hadley, Tables 9-16 with mortality in Chicopee, and Tables 17-24 with mortality in Holyoke. For each CT and town, cause-specific observed and expected deaths and SMRs are given for the entire 1969-85 period and for the 1969-74, 1975-79 and 1980-85 time intervals.

Among the male residents of South Hadley, a slightly higher than expected number of deaths from cancer of the urinary bladder and leukemia were observed during 1969-85 for the town as a whole. This excess, though, is not statistically significant. However, the number of prostate cancer deaths was significantly greater than the number expected (Table 4). Significantly higher mortality of prostate cancer was particularly evident among male residents of CT 8213. Additionally, there was a statistically significant excess in the number of deaths due to leukemia among males in that same CT (Table 3).

The data do not indicate an excessive risk of death from lung cancer among the male or female residents of South Hadley (Tables 1 and 5). There was also no excess in bladder cancer mortality among the female residents of South Hadley (Tables 6-7). Table 8 shows mortality data for cancer of female reproductive organs in South Hadley. There appears to be a slight excess in the risk (SMR = 1.27), but it is not statistically

significant. However, a significantly greater than expected number of deaths from leukemia (SMR = 2.55) occurred during 1975-79 among females (Table 7). Most of leukemia deaths occurred among female residents of CT 8211.

Among the male residents of Chicopee, a slightly higher than expected number of deaths from lung cancer, bladder cancer and leukemia were observed in the 1969-85 period (Tables 9-11). SMRs for these causes of death are between 1.1 and 1.2. The SMR for lung cancer during the period 1969-85 is statistically significant. Lung cancer SMRs for the 1969-74 time interval and for CT 8111 and 8112 are also significantly greater than 1.0 (Table 9). Though statistically not significant for the entire 1969-85 period leukemia mortality was significantly greater than expected for the 1980-85 time period. SMRs for leukemia in that time interval were significantly greater than 1.0 for CT 8113 and for the town of Chicopee (Table 11). Table 12 shows that observed deaths from cancer of the prostate gland in the 1969-85 period were as expected, with the exception of CT 8113; the SMR for CT 8113 being significantly greater than 1.0.

Among female residents of Chicopee, there was no apparent excess in lung cancer and leukemia mortality (Tables 13 and 15) during the period 1969-85. The number of bladder cancer deaths among Chicopee females was significantly (statistically) greater than expected in the 1980-85 time interval (table 14). Table 16 shows that SMRs for cancer of female reproductive organs are significantly greater than 1.0 in CT 8110, particularly in the 1975-79 time interval, but not in Chicopee as a whole.

With the exception of cancer of the prostate, there was no excess in cancer mortality among the residents of Holyoke (Tables 17-24). When the

results are further examined by CT, however, the SMR for lung cancer among male residents of CT 8116 was 1.4 and statistically significant (Table 17). Excessive risk of death from lung cancer is also observed among the male residents of CT 8114. But this statistically significant result was observed only in the 1980-85 time interval. Table 20 shows that SMRs for prostate cancer were significantly greater than 1.0, particularly in the 1975-79 time interval and in CTs 8116, 8117 and 8120.

Among the female residents of Holyoke, the SMR for lung cancer is also significantly greater than 1.0 in CT 8116 (Table 21), and the SMRs for cancer of urinary bladder and reproductive organs are significantly greater than 1.0 in CT 8117 (Tables 22 and 24). The SMRs for bladder cancer in CTs 8114 and 8118 are also greater than 1.0 (Table 22), but they are based on small numbers of deaths and lack statistical confidence.

Cancer mortality among the residents of the four CTs surrounding the JRG plant (CT 8113, 8114, 8117 and 8211) is given in Tables 25 and 26. It appears that there has been a greater than expected risk of death from prostate cancer during 1969-85 in these four CTs, particularly in the 1969-74 time interval (Table 25). This elevation in mortality is statistically significant. Tables 25 and 26 also show male and female mortality from urinary bladder cancer. A statistically significant excess number of bladder cancer deaths was observed among females during the period 1969-85 (SMR = 2.03). This excess is particularly apparent during the 1980-85 period. The data do not indicate excessive risk of death from lung cancer, leukemia, breast cancer, or cancer of female reproductive organs among residents of the four CTs surrounding the JRG plant.

Cancer mortality examined according to time intervals (1969-74,

1975-79, and 1980-85) suggest that the risk (SMRs) of lung cancer and cancer of reproductive organs among females in South Hadley (Tables 5 and 8), leukemia among males in Chicopee (Table 11), bladder cancer among males in Holyoke (Table 18), and bladder cancer among females in the four CTs surrounding the JRG plant (Table 26) has increased over time. Similar time trends in the risk of different cancers can be seen among the male residents of several different CTs. However, these trends should be interpreted with caution since most SMRs are based on small numbers of deaths and their magnitude may fluctuate by chance. Furthermore, SMRs for different time intervals may not be directly comparable to each other.

Incidence

Although the incidence of each of the cancers of interest was pooled together over the years 1982 through 1984 for analysis, the numbers of cases of certain cancers were rather small. Tables 27-29 show the observed and expected cancer incidence in South Hadley. The incidence of lung cancer among the male residents of South Hadley was a little less than expected (0.89), while the lung cancer SIR for females was slightly greater than expected (1.5), however not statistically significant (Table 27). There was only one case of female bladder cancer diagnosed among the residents of South Hadley and the SIR for bladder cancer among males (1.7) was not significantly different from 1.0 (Table 28). Table 29 presents male and female leukemia incidence. There were no female cases observed and the number of male cases observed is not significantly different than the number expected. The incidence of prostate cancer in South Hadley was lower than expected (Table 30). The incidence of female breast cancer was also below expectation, but among the female residents of CT 8213 the SIR for breast cancer is significantly greater than 1.0 (Table 31). The incidence of cancer of the female reproductive organs was more than twice the expected incidence in South Hadley and in CT 8211 (Table 31). These SIRs are statistically significant.

Tables 32-36 show the observed and expected cancer incidence in Chicopee. Among the residents of the entire town of Chicopee, there was no excess in the incidence of leukemia and cancers of the lung, prostate, breast and female reproductive organs (Tables 32 and 34-36). In the case of bladder cancer, there was significantly greater than expected incidence among the male residents (SIR = 1.6), but not among the female residents

(Table 33). The excess in bladder cancer incidence among males is particularly apparent in CT 8106. SIRs for lung cancer and prostate cancer among the residents of CT 8112 in Chicopee were 1.5 to 1.6, but not significantly greater than 1.0 (Tables 32 and 35).

Among the residents of the entire town of Holyoke, the only excess in cancer incidence appears to be of urinary bladder cancer among females (Tables 37-41). Sixteen cases of bladder cancer were diagnosed in 1982-84, while 10.4 cases were expected (Table 38). This difference, however, is not statistically significant. Tables 37-41 show that among the SIRs for individual CTs, only the SIRs for prostate cancer and breast cancer in CT 8120 were significantly greater than 1.0. The SIRs for lung cancer among males in CT 8114 and females in CT 8118, and SIRs for cancer of female reproductive organs in CTs 8118 and 8120 are greater than 1.0 (1.5 to 1.8), but the differences are also not statistically significant (Tables 37 and 41).

Table 42 shows aggregated incidence of cancers among the residents of CTs 8113, 8114, 8117 and 8211 (the CTs surrounding JRG plant).

The SIRs for lung cancer among females and urinary bladder cancer in both males and females are greater than 1.0, however, none of these SIRs are statistically significant. In addition, the data do not suggest excessive incidence of any other cancer in the four CT area.

The combined mortality and incidence data for each town suggest that, relative to the State of Massachusetts, a greater than expected risk of lung cancer and bladder cancer was present in South Hadley and Chicopee; prostate cancer in South Hadley and Holyoke; and, cancer of the female reproductive organs in South Hadley. The data for individual CTs suggest

that the greater risk of cancer in South Hadley was largely in CT 8213 (Tables 3, 4, 8, 27 and 31). The greatest risk of cancer in Chicopee appears to have been mainly in the CTs on the west side of the town along the Connecticut river. In Holyoke, the greatest risk of cancer seems to be in densely populated CTs on the central-east side of the town along the Connecticut river.

Tables 43-45 show the smoking status of the cases of lung, bladder and colo-rectal cancers diagnosed in 1982-1984 among the residents of South Hadley, Chicopee and Holyoke. Although there are limitations to the use of this data, it is important to note that 83% to 100% of male lung cancer cases and 71% to 74% of female lung cancer cases were smokers (current or ex-smokers). When compared with the proportion of colo-rectal cancer cases who were smokers (32% to 45% of males and 17% to 32% of females), the results suggest that smoking is associated with lung cancer, an expected finding. The numbers of bladder cancer cases for whom smoking status was known were too small to make meaningful comparisons.

The data on the smoking status of the adult general population of South Hadley, Chicopee and Holyoke in 1986 are given in Tables 46-48. These data are from the Massachusetts Health Interview Survey (HIS). The prevalence of smoking among the survey participants is shown in Table 49. From the residents of South Hadley, only two men participated in the survey (Table 46) and the number of participants who resided in Chicopee and Holyoke are 45 and 21 respectively. The prevalence of smoking (current and ex-smokers) among the entire survey population was 59% for males and 52% for females (Table 49). In comparison to this standard, the prevalence of smoking among Chicopee males and females was 60% and 64% respectively (Table 47). The prevalence of smoking among the participants

from Holyoke was a little lower than that of the entire survey sample (Tables 48-49).

The HIS was not developed or administered for the purpose of delineating the prevalence of smoking in individual towns and since the number of survey participants from the three towns was small, the value of the smoking data derived from these individuals is limited in this investigation. However, the data is included to provide some perspective on the prevalence of smoking among the general population of the towns. When the prevalence rates of smoking derived from the HIS are compared with the prevalence of smoking among cancer cases in Chicopee and Holyoke (Tables 44-45), the prevalence is higher among the lung cancer cases and lower among the colo-rectal cancer cases. This finding again supports the conclusion that lung cancer cases in the towns smoke more than individuals without lung cancer.

Tables 50-52 show the usual occupation for cases of lung cancer, bladder cancer and colo-rectal cancer diagnosed in 1982-84 among the residents of South Hadley, Chicopee and Holyoke. The occupational titles and industries reported to the Cancer Registry varied extensively. Consequently, the occupations are described by the major type of industry. Even so, the number of cases in each of the ten industrial categories were too small for meaningful comparisons (Tables 50-52). Furthermore, occupational data for approximately 59% of the cancer cases were not known to the Cancer Registry, thus limiting the interpretation of this information.

DISCUSSION

In interpreting the differences between the observed and expected cancer incidence or mortality (i.e., SIR or SMR) in this investigation, statistical significance was set at the traditional level of 5%. It may be argued that if this level was raised to 10%, more of the SMRs and SIRs would be statistically significant. In doing so, however, misleading conclusions may be drawn from differences which really may not exist. Conversely, setting a very low level of statistical significance may lead to rejecting true differences. The statistical significance of an SMR or SIR is largely influenced by the number of events observed. In table 9, for example, the SMR of 1.1 for lung cancer among the male residents of Chicopee is significantly (statistically) greater than 1.0, while the SIR of 6.36 for leukemia among the male residents of South Hadley (Table 29) is not. The reason is that the SMR of 1.1 was based on 352 observed deaths from lung cancer, while the SIR of 6.36 was based on only 3 observed cases of leukemia. The small numbers of observed events and consequent low statistical power made the interpretation of SMRs or SIRs for individual CTs difficult in this investigation.

Small numbers of incident cases and low statistical confidence in the SIRs may also have been the reason for the inconsistency between the magnitude of SMRs and SIRs for specific cancers. Generally, an increase in cancer incidence in a population is correlated with mortality from the cancer. This pattern is not consistently seen in the cancer data for the three towns. For example, SMRs for prostate cancer were significantly greater than 1.0 for South Hadley, Holyoke, and the four CTs surrounding

the JRG plant (Tables 4, 20, and 25), but the incidence of prostate cancer was not elevated in these areas (Tables 30, 40, and 42). Similar inconsistency between incidence and mortality can be seen for lung cancer and bladder cancer in South Hadley and Chicopee, and cancer of the female reproductive organs in South Hadley. It may be that the incidence for three years (1982-84) for each CT or town is determined over too short a time frame and is subject to chance fluctuations and does not represent the true risk of cancer in the area.

In this investigation, nearly 800 SMRs and SIRs were computed. Since the statistical significance level was set at 5%, approximately 40 ratios would appear statistically significant by chance. Consequently, some of the statistically significant SMRs and SIRs in Tables 1-42 may be different from 1.0 by chance.

SMRs and SIRs are measures of risk in the study population relative to the risk in a standard population. Consequently, the choice of the standard population is critical. In most developed countries, the risk of cancer is higher among urban populations than rural populations. In this investigation, the three-town (study) area is urbanized and industrialized. The population of Massachusetts is a mixture of urban and rural populations. It is, therefore, to be expected that the risk of cancer in the three towns would appear higher than that in Massachusetts. taken as a whole.

Despite the limitations in interpretation, the results show elevated risk of cancers of the prostate, bladder, lung and female reproductive organs. It is not surprising to find that elevated risk of cancer is predominantly in the river basin i.e. the CTs along the Connecticut river. Three of the four CTs surrounding the JRG plant (CT 8113, 8114,

and 8117) are also in the river basin (Figure 1). This area is the oldest section of the three towns and is densely populated and industrialized.

Cancers of the lung and bladder are known to be associated with environmental pollution. Besides tobacco smoke and ionizing radiation, the risk factors for lung cancer include exposure to asbestos, radon gas, mustard gas, hexavalent chromium, chloromethyl ethers, nickel, and inorganic arsenic. Bladder cancer is also associated with smoking and ionizing radiation. Occupational risk factors for bladder cancer are exposures to aromatic amines in the dyestuff and rubber industries (e.g. benzidine and 2-naphthylamine) and other organic chemicals (e.g., in leather and printing industry). A high consumption of coffee and Schistosoma haematobrium infection are also known risk factors for bladder cancer. Cancers of the prostate and female reproductive organs are largely hormone dependent cancers. Cancer of the cervix is a sexually transmitted disease. Cancers of the ovary and uterus are also associated with obesity. The only known environmental risk factor for prostate cancer is occupational exposure to cadmium (e.g., in welding, electroplating, and alkaline battery production). Viral infection has been suspected to be a risk factor for prostate cancer.

Like most chronic diseases, cancers do not appear immediately or soon after exposure to carcinogens (cancer causing substances or energy). There is a certain latency that varies with the type of cancer and the type and dose of exposure to the carcinogen. Latency is generally defined as the average time period from exposure to carcinogen(s) to the manifestation (diagnosis) of cancer. The average latency for cancers is 15 to 20 years. Consequently, if the general environmental pollution caused the excessive cancers in South Hadley, Chicopee and Holyoke, it

must be the pollutants present in the area some 15-20 years before the cancers were diagnosed.

If a cancer case was diagnosed or died in a town where he/she lived for only a few years before the diagnosis, that cancer is not likely to be due to environmental carcinogens in the town. It is, therefore, necessary to consider latency when the risk of a cancer is being assessed. It is also necessary to establish that the population "at risk" of developing cancer were or could have been exposed to carcinogens. In order to establish the exposure to general environmental pollution in the three towns, status of the study cancer cases and deaths, attempts were made to compare their residential addresses at the time of diagnosis/death with their residential addresses 15 to 20 years before diagnosis/death. It was possible to trace a case back by searching city directories. However, if the case had changed residential address within a town, it was not possible to establish that it was the same person, since information on identifiers other than the name was not available. Even the name is not useful for tracking a case if the case had changed his/her last name. The residential status and the potential for exposure to general environmental pollution can be established by surveying the study population and obtaining residential histories, but this was beyond the scope of this investigation.

It is possible that ambient air in the three towns was polluted 20 to 30 years ago and that the air pollutants were potential carcinogens. There is, however, no firm evidence to support this possibility. As previously mentioned, historical data on air pollution are not available. The DEQE Source Inventory includes data on volatile organic compounds (VOCs), but the inventory began in 1980. Even if historical data on air

pollution in the three towns were available for this investigation, it would be quite difficult to establish a cause and effect relationship between past air pollution and the risk of cancer. This is because the exposure status of individuals or groups within the three-town area population is not known.

In an industrial area such as sections of South Hadley, Chicopee and Holyoke, some air pollution is to be expected from the industrial processes and the materials used or produced. It is very likely that 20 or 30 years ago toxic pollutants were emitted by the local industry. The topography of the area is such that plumes of polluted air may have been trapped in the valley. Consequently, the residents of the old sections of the three towns (along the Connecticut river) could have been exposed to polluted air.

The JRG plant is a large chemical plant. Among the manufacturing industries located in the three towns that are known to emit VOCs, the JRG plant has recently been releasing the greatest amount (tons/year) of VOCs (Appendix A). It may be that 20 to 30 years ago, the JRG plant was releasing even greater amounts of VOCs and other toxic substances in the air. However, the JRG plant can not be singled out as the only possible source of historical air pollution in the area. There were other industries in the area (Appendix B) that could have contributed to air pollution. Furthermore, the source(s) of air pollution (if it existed) in the three-town area could have been in the neighboring towns or the City of Springfield.

Because of the initiatives within the last five years to address toxic air pollutant issues, along with stepped up compliance efforts, some data on volatile organic emissions are available, and it may be worthwhile

to consider modelling emissions. However, meteorologic conditions along the Connecticut River are unique because of the valley conditions and prevailing north-south winds. These conditions may lead to a buildup of pollutants within the valley. It is also likely that some sources outside of the three-town area may also impact the air quality of that area. Modelling or monitoring of conditions now will yield information on present conditions only. Estimating past levels of air pollution in the area is not possible since the nature and the quantities of historical pollutants released into the environment are not known.

Reliable estimates suggest that over 70% of environmental cancers are attributable to diet, nutrition, and life-style factors particularly cigarette smoking and consumption of alcoholic beverages. The data on smoking used in this investigation were the best data available to DPH. The numbers of cancer cases in each town and the numbers of town residents participating in the Massachusetts Health Interview Survey were small (Tables 43-49). Two out of approximately 12,000 adult residents of South Hadley, 45 out of approximately 41,000 adult residents of Chicopee, and 21 out of approximately 30,500 adult residents of Holyoke participated in the statewide Health Interview Survey.

The information about cigarette smoking that was required for this investigation was a history of smoking 15-20 years before the diagnosis of cancer among the cases. Unfortunately, the smoking data obtained from the Cancer Registry and the Health Interview Survey were not designed to provide this information. In order to study the effects of smoking on the risk of cancer, it is necessary to survey the cancer cases and a comparable group of control subjects and obtain a lifetime smoking history. However, given the medical literature available on cigarette

smoking, coupled with the findings, the data suggest that part of the risk of lung cancer in the three-town area may be explained by cigarette smoking.

The limitations in the use of occupational data were similar to those of the smoking data. The occupations of 59% of the cancer cases were not known and the numbers of cases in each of ten major industry or occupation categories were to small for comparing one cancer group with another. In any case, the occupation used for this investigation was the usual or recent occupation recorded on Cancer Registry records. It is, however, not known if this occupation was held 15 to 20 years (latency) before the diagnosis of the case. Furthermore, there was no information about jobs held before the initiation of the cancer. Complete lifetime occupational history is necessary to correctly classify past exposures to potential carcinogens. If a cancer case, for example, had been exposed to a carcinogen in the course of his work but this work was not his usual occupation, then the use of only his usual occupation would miss the association between exposure to the carcinogen and the cancer.

The usual or recent occupation is also recorded on death certificates. In the Commonwealth of Massachusetts this information has been computerized since 1982. Because of the incompleteness of the occupational history on death certificates, occupational data from this source were not used in this investigation. Although reliable historical data on occupational exposures are not known, it is plausible that some of the residents of the three towns had been exposed to toxic substances in the course of their work.

CONCLUSIONS/RECOMMENDATIONS

The results of this descriptive study suggest that the risk of cancer of lung, bladder, prostate, and female reproductive organs has been higher in South Hadley, Chicopee and Holyoke than in the State of Massachusetts as a whole. Extensive research has been carried out in many countries to determine the causes of lung cancer and bladder cancer, and several environmental risk factors for these cancers have been identified. The main risks factors for these cancers are exposure to radiation, smoking, occupational exposures, and certain dietary and nutritional factors. These risks are preventable. All efforts should be directed toward making use of the existing knowledge about the risk factors and reducing the risk of cancer in the three-town area by eliminating exposures to carcinogens. The local officials of the three towns, local medical community and concerned citizens should work together with appropriate state agencies to develop a comprehensive program for controlling cancer in the area.

For its part DPH proposes a two pronged approach in response to the findings of this investigation. First in collaboration with local boards of health, medical providers and citizens, DPH will plan and conduct a program of primary and secondary prevention of cancer. This program will make use of health education and health promotion techniques to reduce life-style risks for cancer and to promote screening and early detection of and treatment of cancer. A draft proposal for a cancer prevention program entitled "A Planned Approach to Community Health (PATCH)" is given in Appendix C. This plan is aimed at reducing cigarette smoking and dietary intake of fats and alcohol, providing education on these risk

factors, providing information to the citizens about the availability of screening and treatment of cancer, and providing professional education on prevention of cancer for primary care physicians. Secondary prevention efforts, early detection and treatment of cancer, may contribute to the reduction of cancer mortality of each of the cancer types in this investigation. Primary prevention efforts, reducing the risk of developing cancer, described in PATCH also can contribute to the reduction of cancer mortality as well as incidence of each of the cancer types discussed in this report. This can be accomplished by focussing efforts on the known major risk factors for bladder and lung cancer (smoking) and for prostate and female reproductive organ cancer (dietary fat intake).

The second approach addresses a major finding of this investigation; the observed excess risk of bladder cancer. This finding is important for two reasons. First, the medical literature indicates some environmental and occupational factors are known to be associated with the development of bladder cancer. Second, unlike the results for the other cancer types, both mortality and incidence were frequently found to be elevated. Although the elevations were not always statistically significant, the consistency of the elevations and the excess observed in both males and females in some geographic areas warrant the further study of this cancer type. Due to the limited information that can be collected on the cases from existing records, a case-control study of bladder cancer should be conducted. This would make available essential and otherwise unavailable information that may indicate whether or not an environmental association with the development of bladder cancer is likely. It should be recognized that the conduct of such a study will require additional funding resources. Epidemiologic studies take a long time to conduct and are

expensive. The local officials, local medical providers and concerned citizens might also consider the following:

- Coordination of efforts with the Division of Occupational Hygiene (DOH) to increase its efforts in the three towns and target those industries where exposures to potential carcinogens are suspected. DOH could maximize the utilization of its new data base under the Right-to-Know program to obtain information on potential carcinogens.

- Coordination of efforts with the U.S. Occupational Health and Safety Administration (OSHA) might conduct occupational hygiene follow-ups if DOH finds that excessive occupational exposures exist or that personal protection from harmful exposures is inadequate in the three town area.

- Coordination of efforts with the Department of Environmental Quality Engineering in order to vigorously pursue compilation of a complete source inventory for the area that quantifies levels of potential carcinogens being emitted from industrial plants. DEQE should also target the plants emitting large quantities of potential carcinogens in the air and implement strict air pollution control. This is particularly necessary in this three-town area because of the "valley effect" on air pollution levels. DEQE could review requirements for additional engineering control at the industrial plants in the area that are emitting large quantities of air pollutants. DPH could provide technical assistance to DEQE as and when required.

Table 1. Observed and expected deaths from lung cancer among male residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	9	6.2	1.45	8	6.9	1.15	13	9.6	1.36	30	22.75	1.32
8211	6	13.7	0.44	11	12.9	0.86	12	16.8	0.71	29	43.36	0.67*
8213	2	5.1	0.39	2	5.5	0.36	3	7.6	0.39	7	18.22	0.38*
Total	17	25.0	0.68	21	25.3	0.83	28	34.0	0.82	66	84.33	0.78*

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 2. Observed and expected deaths from bladder cancer among male residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	1	0.6	1.57	0	0.7	-	2	0.9	2.33	3	2.2	1.38
8211	5	1.7	3.00	1	1.4	0.72	1	1.6	0.62	7	4.6	1.51
8213	2	0.6	3.40	0	0.6	-	0	0.7	-	2	1.9	1.03
Total	8	2.9	2.77*	1	2.7	0.37	3	3.2	0.94	12	8.8	1.37

Expected deaths based on mortality im Massachusetts adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 3. Observed and expected deaths from leukemia among male residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	1	0.8	1.23	1	0.8	1.22	0	1.0	-	2	2.6	0.76
8211	2	1.8	1.10	1	1.5	0.64	1	1.8	0.55	4	5.2	0.77
8213	3	0.7	4.55	2	0.6	3.01	1	0.8	1.22	6	2.1	2.81*
Total	6	3.3	1.82	4	3.0	1.32	2	3.7	0.54	12	10.0	1.20

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 4. Observed and expected deaths from prostate cancer among male residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	3	1.5	2.03	3	1.8	1.65	2	2.7	0.75	8	6.0	1.34
8211	7	4.3	1.65	6	3.9	1.55	7	5.1	1.36	20	13.2	1.51*
8213	2	1.5	1.38	7	1.7	4.16*	6	2.4	2.47*	15	5.6	2.70*
Total	12	7.2	1.67	16	7.4	2.17*	15	10.2	1.46	43	24.8	1.73*

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 5. Observed and expected deaths from lung cancer among female residents of South Hadley and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	3	2.7	1.10	2	2.3	0.86	4	4.2	0.95	9	9.3	0.97
8211	2	5.5	0.36	7	4.7	1.50	11	8.1	1.36	20	18.3	1.10
8213	2	2.1	0.96	0	1.9	-	5	3.3	1.51	7	7.3	0.96
Total	7	10.3	0.68	9	8.9	1.00	20	15.6	1.28	36	34.8	1.03

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 6. Observed and expected deaths from bladder cancer among female residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	0	0.3	-	0	0.3	-	0	0.4	-	0	1.0	-
8211	1	0.9	1.18	1	0.8	1.30	2	0.4	2.15	4	2.5	1.57
8213	0	0.3	-	0	0.3	-	0	0.4	-	0	0.9	-
Total	1	1.4	0.71	1	1.4	0.73	2	1.7	1.19	4	4.5	0.90

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 7. Observed and expected deaths from leukemia among female residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	0	0.6	-	1	0.6	1.74	0	0.8	-	1	2.0	0.51
8211	0	1.5	-	5	1.3	3.89*	1	1.7	0.59	6	4.5	1.34
8213	1	0.5	1.9	0	0.5	-	0	0.7	-	1	1.7	0.59
Total	1	2.6	0.38	6	2.4	2.55*	1	3.2	0.32	8	8.1	0.98

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 8. Observed and expected deaths from cancer of reproductive organs among female residents of South Hadley, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8210	3	1.8	1.64	3	1.8	1.70	4	2.2	1.79	10	5.8	1.72
8211	2	4.6	0.44	5	3.7	1.34	6	4.5	1.33	13	12.8	1.02
8213	1	1.6	0.61	2	1.5	1.36	4	1.8	2.18	7	4.9	1.42
Total	6	8.0	0.75	10	7.0	1.43	14	8.6	1.63	30	23.6	1.27

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 9. Observed and expected deaths from lung cancer among male residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	5	7.3	0.68	8	8.6	0.92	15	12.1	1.24	28	28.1	1.00
8107	10	14.1	0.71	16	13.6	1.17	19	18.2	1.04	45	45.9	0.98
8108	12	11.1	1.08	5	9.5	0.52	11	12.2	0.90	28	32.8	0.85
8109	18	17.3	1.04	19	14.6	1.30	17	18.4	0.92	54	50.3	1.07
8110	12	8.9	1.35	9	9.0	1.00	12	12.0	1.00	33	29.9	1.10
8111	29	16.6	1.75*	22	15.2	1.45	19	19.9	0.95	70	51.7	1.36*
8112	16	9.3	1.71*	8	9.9	0.81	16	13.4	1.20	40	32.6	1.23
8113	18	12.5	1.44	14	14.7	0.95	22	20.6	1.07	54	47.8	1.13
Total	120	97.1	1.23*	101	95.2	1.06	131	126.9	1.03	352	319.2	1.10*

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 10. Observed and expected deaths from bladder cancer among male residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs	Exp.	SMR
8106	1	0.8	1.26	1	0.8	1.19	1	1.0	0.96	3	2.7	1.12
8107	0	1.7	-	3	1.5	1.97	4	1.8	2.67	7	5.1	1.38
8108	3	1.6	1.90	0	1.2	-	1	1.3	0.54	4	4.1	0.99
8109	3	2.1	1.41	1	1.6	0.61	4	1.8	2.17	8	5.6	1.42
8110	4	1.0	4.02	0	0.9	-	1	1.1	0.91	5	3.0	1.66
8111	1	2.1	0.48	1	1.8	0.56	4	2.1	1.94	6	5.9	1.02
8112	0	1.1	-	1	1.0	1.00	0	1.2	-	1	3.2	0.31
8113	0	1.3	-	4	1.5	2.72	3	1.9	1.61	7	4.7	1.50
Total	12	11.7	1.02	11	10.3	1.07	18	12.2	1.48	41	34.2	1.20

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 11. Observed and expected deaths from leukemia among male residents of Chicopee, and SMRs SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	0	1.0	-	0	1.1	-	3	1.7	1.80	3	3.8	0.79
8107	3	1.8	1.66	2	1.6	1.23	3	1.9	1.54	8	5.4	1.49
8108	2	1.4	1.39	1	1.1	0.87	0	1.3	-	3	3.9	0.77
8109	1	2.1	0.47	4	1.7	2.34	3	1.9	1.53	8	5.8	1.38
8110	0	1.2	-	1	1.1	0.93	1	1.3	0.77	2	3.6	0.56
8111	0	2.3	-	1	1.9	0.51	2	2.3	0.87	3	6.5	0.46
8112	2	1.3	1.52	1	1.2	0.84	3	1.4	2.09	6	4.0	1.52
8113	0	1.8	-	3	1.8	1.66	7	2.3	3.10*	10	5.9	1.71
Total	8	13.0	0.61	13	11.6	1.12	22	14.2	1.55*	43	38.8	1.11

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 12. Observed and expected deaths from prostate cancer among male residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	0	1.9	-	1	2.2	0.45	5	3.2	1.56	6	7.3	0.82
8107	5	4.5	1.11	2	4.3	0.46	5	5.9	0.85	12	14.7	0.82
8108	2	4.3	0.46	3	3.5	0.87	2	4.4	0.46	7	12.2	0.48
8109	5	5.5	0.91	3	4.7	0.64	2	6.1	0.33	10	16.2	0.62
8110	2	2.4	0.83	4	2.5	1.62	7	3.5	2.02	13	8.4	1.56
8111	9	5.4	1.68	8	5.1	1.58	5	6.9	0.73	22	17.3	1.27
8112	3	2.7	1.13	4	2.6	1.51	1	3.6	0.28	8	8.9	0.90
8113	6	3.2	1.92	7	3.9	1.78	7	5.8	1.20	20	12.9	1.55*
Total	32	29.8	1.07	32	28.8	1.11	34	39.3	0.87	98	97.82	1.00

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 13. Observed and expected deaths from lung cancer among female residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	1	1.9	0.52	2	3.1	0.65	2	5.7	0.35	5	10.7	0.47*
8107	3	3.7	0.80	1	5.0	0.20	13	8.9	1.46	17	17.6	0.97
8108	1	3.1	0.32	4	3.7	1.08	2	6.3	0.32	7	13.1	0.54
8109	1	4.6	0.22	5	5.4	0.93	5	9.1	0.55	11	19.1	0.58*
8110	2	2.1	0.90	3	3.1	0.95	8	5.6	1.42	13	11.0	1.18
8111	7	4.5	1.55	6	6.0	1.00	10	10.5	0.95	23	21.0	1.10
8112	1	2.4	0.41	6	3.3	1.83	7	5.8	1.21	14	11.5	1.22
8113	1	3.4	0.30	9	5.2	1.72	12	9.7	1.24	22	21.0	1.05
Total	17	25.7	0.66*	36	34.8	1.03	59	61.6	0.96	112	124.9	0.90

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 14. Observed and expected deaths from bladder cancer among female residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	0	0.4	-	0	0.4	-	0	0.6	-	0	1.4	-
8107	0	0.8	-	1	0.8	1.24	3	1.0	3.02	4	2.6	1.52
8108	1	0.8	1.21	2	0.7	2.78	0	0.9	-	3	2.4	1.25
8109	2	1.0	1.98	0	0.9	-	0	1.0	-	2	2.9	0.69
8110	0	0.4	-	0	0.4	-	1	0.6	1.81	1	1.4	0.72
8111	2	1.0	1.95	0	1.1	-	4	1.3	2.98	6	3.4	1.75
8112	0	0.5	-	2	0.4	4.83	1	0.5	2.05	3	1.4	2.17
8113	0	0.5	-	0	0.8	-	3	0.9	3.20	3	2.2	1.36
Total	5	5.5	0.91	5	5.5	0.91	12	6.8	1.77*	22	17.8	1.24

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.00, $p < 0.05$

Table 15. Observed and expected deaths from leukemia among female residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	1	0.8	1.23	0	0.8	-	3	1.2	2.55	4	2.8	1.42
8107	1	1.4	0.70	0	1.3	-	2	1.8	1.11	3	4.5	0.66
8108	2	1.2	1.62	0	1.1	-	1	1.4	0.70	3	3.7	0.81
8109	1	1.7	0.57	2	1.4	1.41	3	1.8	1.62	6	5.0	1.19
8110	3	0.9	3.45	1	0.5	1.86	1	1.1	0.90	5	2.5	1.99
8111	2	1.9	1.06	0	1.0	-	5	2.4	2.09	7	5.2	1.34
8112	0	1.0	-	1	0.8	1.23	0	1.1	-	1	2.8	0.35
8113	0	1.4	-	0	1.4	-	1	1.9	0.53	1	4.6	0.22
Total	10	10.3	0.97	4	7.5	0.53	16	12.7	1.26	30	31.3	0.96

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 16. Observed and expected deaths from cancer of reproductive organs among female residents of Chicopee, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8106	2	2.3	0.88	5	2.4	2.09	3	3.1	0.96	10	7.8	1.28
8107	1	4.6	0.22	4	4.0	1.00	1	4.9	0.20	6	13.5	0.45*
8108	4	4.0	1.00	0	3.1	-	4	3.7	1.09	8	10.8	0.74
8109	7	5.6	1.25	4	4.3	0.93	10	5.0	1.99*	21	14.9	1.41
8110	3	2.6	1.16	6	2.4	2.49*	6	3.0	1.97	15	8.1	1.86*
8111	9	5.6	1.61	7	4.9	1.43	7	6.1	1.15	23	16.6	1.39
8112	2	2.9	0.70	2	2.5	0.81	1	3.0	0.33	5	8.3	0.60
8113	5	3.9	1.28	5	4.0	1.25	5	5.2	0.96	15	13.1	1.14
Total	33	31.5	1.05	33	27.5	1.20	37	34.1	1.09	103	93.1	1.11

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.00, $p < 0.05$

Table 17. Observed and expected deaths from lung cancer among male residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	5	7.7	0.65	5	4.7	1.05	11	5.1	2.14*	21	17.6	1.20
8115	9	8.4	1.07	6	5.3	1.13	8	5.7	1.41	23	28.4	0.81
8116	19	13.3	1.43	10	9.1	1.10	16	10.4	1.54	45	32.8	1.37*
8117	9	10.3	0.87	9	7.1	1.27	9	8.1	1.11	27	25.5	1.06
8118	10	9.8	1.02	9	8.4	1.08	10	10.6	0.94	29	28.8	1.01
8119	6	8.1	0.75	13	8.3	1.58	8	11.2	0.71	27	27.4	0.98
8120	14	16.8	0.83	16	16.0	1.00	19	21.5	0.89	49	54.3	0.90
8121	25	20.4	1.22	30	27.2	1.10	39	37.5	1.04	94	85.1	1.10
Total	97	94.8	1.02	98	86.1	1.14	120	110.1	1.09	315	291.0	1.08

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 18. Observed and expected deaths from bladder cancer among male residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	0	0.9	-	0	0.6	-	0	0.6	-	0	2.1	-
8115	1	1.1	0.91	0	0.7	-	1	0.6	1.56	2	2.4	0.84
8116	2	1.7	1.19	2	1.1	1.82	3	1.1	2.62	7	3.9	1.78
8117	2	1.4	1.39	2	0.9	2.19	0	0.9	-	4	3.3	1.22
8118	3	1.2	2.42	0	1.0	-	0	1.1	-	3	3.4	0.89
8119	1	1.0	1.03	0	0.9	-	1	1.1	0.90	2	3.0	0.67
8120	1	2.1	0.46	1	1.9	0.52	2	2.3	0.86	4	6.4	0.63
8121	4	3.5	1.15	1	3.3	0.30	3	4.1	0.74	8	9.0	0.89
Total	14	13.0	1.08	6	10.4	0.58	10	11.9	0.84	30	33.4	0.90

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 19. Observed and expected deaths from leukemia among male residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	1	1.0	0.95	0	0.7	-	0	0.6	-	1	2.3	0.43
8115	0	1.1	-	0	0.7	-	2	0.7	2.75	2	2.6	0.77
8116	1	1.7	0.58	2	1.2	1.69	1	1.2	0.80	4	4.2	0.96
8117	2	1.3	1.53	0	0.9	-	1	0.9	1.11	3	3.0	0.98
8118	1	1.3	0.79	0	1.0	-	0	1.2	-	1	3.5	0.28
8119	1	1.0	0.95	1	1.0	1.01	0	1.2	-	2	3.3	0.61
8120	1	2.2	0.46	3	2.0	1.50	3	2.4	1.24	7	6.6	1.06
8121	4	3.5	1.14	2	3.4	0.59	3	4.2	0.71	9	11.2	0.81
Total	11	13.3	0.83	8	10.9	0.74	10	12.6	0.79	29	36.7	0.79

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 20. Observed and expected deaths from prostate cancer among male residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	2	2.3	0.85	1	1.7	0.60	1	2.0	0.51	4	6.0	0.67
8115	2	2.9	0.68	2	1.9	1.04	0	2.2	-	4	7.0	0.57
8116	10	4.4	2.26*	9	3.2	2.79*	3	3.9	0.77	22	11.5	1.91*
8117	8	3.9	2.03*	0	2.7	-	10	3.2	3.12*	18	9.9	1.82*
8118	5	3.3	1.54	5	2.9	1.74	2	3.8	0.53	12	9.9	1.21
8119	1	2.5	0.40	7	2.6	2.72*	3	3.6	0.83	11	8.7	1.27
8120	6	5.7	1.06	13	5.7	2.30*	11	7.8	1.41	30	19.1	1.57*
8121	7	9.3	0.75	9	9.8	0.92	11	13.7	0.80	27	32.8	0.82
Total	41	34.4	1.19	44	30.5	1.44*	41	40.1	1.02	129	104.7	1.23*

Expected deaths based on mortality in Massachusetts, adjusted in age

Table 21. Observed and expected deaths from lung cancer among female residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	4	1.9	2.11	0	1.7	-	4	2.4	1.69	8	5.9	1.35
8115	1	2.0	0.50	2	1.7	1.15	1	2.4	0.41	4	6.2	0.65
8116	9	4.4	2.03*	8	3.9	2.05*	13	5.6	2.34*	30	13.9	2.16*
8117	3	2.9	1.03	1	2.9	0.34	3	4.6	0.65	7	10.5	0.67
8118	4	3.4	1.18	4	3.5	1.13	6	5.6	1.08	14	12.5	1.12
8119	3	2.3	1.33	3	3.6	0.83	5	6.7	0.74	11	12.6	0.87
8120	5	5.4	0.93	5	6.8	0.74	6	11.7	0.51	16	23.9	0.67
8121	4	7.0	0.57	7	9.6	0.73	10	17.2	0.58*	21	33.9	0.62*
Total	33	29.3	1.13	30	33.8	0.89	48	56.2	0.85	111	119.3	0.93

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.00, $p < 0.05$

Table 22. Observed and expected deaths from bladder cancer among female residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	1	0.4	2.50	1	0.3	3.65	0	0.3	-	2	1.0	2.07
8115	1	0.5	2.16	0	0.3	-	0	0.3	-	1	1.1	0.94
8116	1	1.2	0.83	0	0.8	-	2	0.8	2.54	3	2.8	1.09
8117	2	0.9	2.38	2	0.6	3.18	2	0.7	2.79	6	2.2	2.73*
8118	3	0.9	3.49	2	0.6	3.09	0	0.7	-	5	2.2	2.23
8119	0	0.5	-	0	0.7	-	2	0.9	2.12	2	2.1	0.93
8120	0	1.4	-	1	1.3	0.75	1	1.6	0.61	2	4.4	0.45
8121	0	1.8	-	0	1.8	-	1	2.3	0.43	1	6.0	0.17
Total	8	7.5	1.07	6	6.5	0.93	8	7.7	1.03	22	21.7	1.01

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.00, $p<0.05$

Table 23. Observed and expected deaths from leukemia among female residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	0	0.8	-	0	0.5	-	0	0.6	-	0	1.8	-
8115	3	0.8	3.65	0	0.5	-	0	0.6	-	3	1.9	1.54
8116	0	1.9	-	3	1.2	2.48	0	1.8	-	3	4.9	0.61
8117	1	1.2	0.82	2	0.9	2.21	1	1.1	0.89	4	3.3	1.23
8118	1	1.4	0.73	1	1.0	0.98	1	1.3	0.79	3	3.7	0.82
8119	2	0.9	2.19	1	1.1	0.93	2	1.6	1.28	5	3.6	1.41
8120	3	2.3	1.33	3	2.0	1.47	5	2.8	1.81	11	7.1	1.56
8121	2	3.0	0.68	2	2.9	0.69	3	4.0	0.76	7	9.8	0.71
Total	12	12.2	0.98	12	10.2	1.18	12	13.62	0.88	36	36.0	1.00

Expected deaths based on mortality in Massachusetts, adjusted for age

Table 24. Observed and expected deaths from cancer of reproductive organs among female residents of Holyoke, and SMRs according to census tract and time interval

Census Tract	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
8114	1	2.3	0.43	1	1.3	0.75	1	1.4	0.74	3	5.0	0.60
8115	1	2.5	0.40	2	1.4	1.42	0	1.4	-	3	5.3	0.56
8116	6	5.8	1.03	1	3.3	0.30	3	3.3	0.91	10	12.4	0.81
8117	9	3.9	2.31*	3	2.6	1.17	5	2.8	1.78	17	9.3	1.84*
8118	6	4.4	1.38	3	2.9	1.03	5	3.2	1.55	14	10.5	1.33
8119	0	2.7	-	2	3.0	0.66	4	4.0	1.00	6	9.7	0.62
8120	7	7.0	1.00	1	5.7	0.17	7	7.0	1.01	15	19.7	0.76
8121	8	8.9	0.90	10	8.1	1.24	9	10.1	0.89	27	27.1	1.00
Total	38	37.5	1.01	23	28.3	0.81	34	33.1	1.03	95	98.9	0.96

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.00, $p < 0.05$

Table 25. Observed and expected deaths from cancer among male residents of census tracts along surrounding James River Graphics plant, and SMRs according to time interval

Cancer	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
Lung	38	44.2	0.86	39	39.4	0.99	54	50.7	1.07	131	134.3	0.98
Urinary Bladder	7	5.4	1.31	7	4.4	1.61	4	5.0	0.80	18	14.7	1.23
Leukemia	5	6.0	0.84	4	4.9	0.82	9	5.6	1.60	18	16.5	1.09
Prostate	23	13.7	1.68*	14	12.2	1.15	25	16.1	1.54	62	42.0	1.48*

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 26. Observed and expected deaths from cancer among female residents of census tracts surrounding James River Graphics plant, and SMRs according to time interval

Cancer	1969-74			1975-79			1980-85			1969-85		
	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
Lung	10	13.7	0.73	17	14.5	1.17	30	24.8	1.21	57	55.6	1.02
Urinary Bladder	4	2.6	1.52	4	1.9	2.12	7	2.9	2.43*	15	7.4	2.03*
Leukemia	1	4.9	0.21	7	4.0	1.74	3	5.2	0.57	11	14.2	0.77
Reproductive organs	17	14.7	1.15	14	11.6	1.20	17	13.9	1.23	48	40.2	1.19

Expected deaths based on mortality in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 27. Observed and expected incidence of lung cancer in 1982-84 among the residents of South Hadley, and SIRs according to census tract

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8210	5	5.7	0.87	3	2.6	1.05
8211	8	9.9	0.81	8	5.3	1.52
8213	5	4.5	1.12	5	2.2	2.30
Total	18	20.1	0.89	16	10.3	1.55

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 28. Observed and expected incidence of bladder cancer in 1982-84 among the residents of South Hadley, and SIRs according to census tract

Census Tract	Male cases			Female cases		
8210	3	1.7	1.82	0	0.6	-
8211	6	2.9	2.10	1	1.4	0.73
8213	1	1.2	0.78	0	0.5	-
Total	10	5.8	1.73	1	2.6	0.39

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 29. Observed and expected incidence of leukemia cancer in 1982-84 among the residents of South Hadley, and SIRs according to census tract

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8210	1	0.6	1.61	0	0.4	-
8211	0	1.1	-	0	0.9	-
8213	3	0.5	6.36	0	0.4	-
Total	4	2.2	1.84	0	1.7	-

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 30. Observed and expected incidence of prostate cancer in 1982-84 among male residents of South Hadley, and SIRs according to census tract

Census Tract	Male		
	Obs.	Exp.	SIR
8210	3	4.7	0.64
8211	8	8.7	0.92
8213	1	4.0	0.25
Total	12	17.3	0.69

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 31. Observed and expected incidence of cancer of the breast and reproductive organs in 1982-84 among female residents of South Hadley, and SIRs according to census tract

Census Tract	Breast Cancer			Cancer of Reproductive organs		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8210	3	7.9	0.38	6	3.1	1.91
8211	8	14.6	0.55*	14	5.9	2.39*
8213	11	6.0	1.83*	4	2.4	1.66
Total	22	28.5	0.77	24	11.4	2.10*

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 32. Observed and expected incidence of lung cancer in 1982-84 among the residents of Chicopee, and SIRs according to census tract and time intervals

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8106	7	7.3	0.96	1	3.8	0.26
8107	10	10.6	0.94	10	5.8	1.73
8108	4	7.0	0.57	3	4.0	0.76
8109	8	10.7	0.74	4	5.9	0.67
8110	5	7.2	0.70	3	3.8	0.80
8111	13	11.5	1.13	8	6.8	1.18
8112	12	8.0	1.49	6	3.9	1.52
8113	13	12.4	1.05	7	6.5	1.08
Total	72	74.8	0.96	42	40.5	1.04

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 33. Observed and expected incidence of bladder cancer in 1982-84 among the residents of Chicopee, and SIRs according to census tract and time intervals

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8106	6	2.1	2.82*	0	0.9	-
8107	4	3.0	1.31	3	1.5	2.03
8108	3	2.0	1.50	0	1.2	-
8109	6	3.1	1.95	1	1.5	0.87
8110	2	2.1	0.97	2	0.9	2.25
8111	5	3.3	1.51	1	1.9	0.54
8112	4	2.3	1.73	0	0.8	-
8113	5	3.5	1.41	2	1.5	1.33
Total	35	21.5	1.63*	9	10.2	0.88

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 34. Observed and expected incidence of leukemia in 1982-84 among the residents of Chicopee, and SIRs according to census tract and time intervals

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8106	2	0.8	2.46	0	0.7	-
8107	0	1.1	-	2	0.9	2.11
8108	1	0.7	1.39	2	0.7	2.83
8109	1	1.1	0.90	0	1.0	-
8110	3	0.8	3.80	1	0.6	1.62
8111	1	1.3	0.76	2	1.3	1.59
8112	0	0.9	-	0	0.6	-
8113	1	1.4	0.73	0	1.0	-
Total	9	8.1	1.11	7	6.8	1.03

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 35. Observed and expected incidence of prostate cancer in 1982-84 among the residents of Chicopee, and SIRs according to census tract

Census Tract	Obs.	Exp.	SIR
8106	8	5.8	1.38
8107	6	9.7	0.62
8108	6	6.9	0.88
8109	10	9.9	1.01
8110	8	5.9	1.36
8111	13	10.9	1.19
8112	10	6.4	1.56
8113	14	10.0	1.40
Total	75	65.4	1.15

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 36. Observed and expected incidence of cancer of the breast and reproductive organs in 1982-84 among female residents of Chicopee, and SIRs according to census tract

Census Tract	Breast Cancer			Cancer of Reproductive Organs		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8106	10	10.7	0.93	5	4.3	1.17
8107	18	15.4	1.17	3	6.3	0.48
8108	10	10.9	0.93	2	4.4	0.46
8109	21	15.8	1.33	8	6.4	1.24
8110	18	10.3	1.74*	3	4.2	0.72
8111	18	19.2	0.94	8	7.6	1.05
8112	9	10.7	0.84	2	4.3	0.46
8113	19	17.8	1.07	3	7.2	0.42
Total	123	110.8	1.11	34	55.0	0.62*

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 37. Observed and expected incidence of lung cancer in 1982-84 among the residents of Holyoke, and SIRs according to census tract

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8114	5	2.9	1.71	2	1.5	1.31
8115	2	3.3	0.61	1	1.6	0.63
8116	6	5.9	1.01	2	3.5	0.57
8117	6	4.6	1.32	3	2.8	1.05
8118	7	6.1	1.14	6	3.6	1.69
8119	5	6.6	0.76	4	4.2	0.94
8120	15	12.3	1.22	9	7.4	1.21
8121	20	21.5	0.93	10	10.9	0.91
Total	66	63.2	1.04	37	35.6	1.04

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 38. Observed and expected incidence of bladder cancer in 1982-84 among the residents of Holyoke, and SIRs according to census tract

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8114	1	0.8	1.21	0	0.4	-
8115	0	0.9	-	0	0.4	-
8116	3	1.7	1.78	2	1.0	1.91
8117	2	1.3	1.53	3	0.9	3.28
8118	1	1.8	0.57	2	1.0	2.00
8119	2	1.9	1.06	2	1.2	1.60
8120	5	3.5	1.41	5	2.2	2.28
8121	7	6.1	1.15	2	3.1	0.64
Total	21	18.0	1.16	16	10.4	1.54

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 39. Observed and expected incidence of leukemia in 1982-84 among the residents of Holyoke, and SIRs according to census tract

Census Tract	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8114	0	0.4	-	0	0.3	-
8115	0	0.4	-	0	0.3	-
8116	2	0.7	2.86	1	0.7	1.40
8117	0	0.5	-	0	0.5	-
8118	0	0.7	-	2	0.6	3.08
8119	0	0.7	-	0	0.8	-
8120	1	1.3	0.74	1	1.4	0.71
8121	1	2.3	0.43	2	2.0	0.99
Total	4	7.0	0.57	6	6.8	0.89

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 40. Observed and expected incidence of prostate cancer in 1982-84 the residents of Holyoke, and SIRs according to census tract

Census Tract	Male		
	Obs.	Exp.	SIR
8114	1	3.0	0.34
8115	0	3.3	-
8116	7	6.0	1.17
8117	4	4.9	0.81
8118	5	5.9	0.84
8119	7	5.9	1.19
8120	21	12.2	1.72*
8121	15	21.2	0.71
Total	60	62.3	0.96

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 41. Observed and expected incidence of cancer of the breast and reproductive organs in 1982-84 among female residents of Holyoke, and SIRs according to census tract

Census Tract	Breast Cancer			Cancer of Reproductive organs		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
8114	2	4.3	0.47	1	5.2	0.19
8115	2	4.6	0.44	3	1.8	1.65
8116	10	9.9	1.01	2	4.0	0.25
8117	5	7.7	0.65	3	3.1	0.97
8118	7	9.8	0.71	7	3.9	1.77
8119	12	12.1	0.99	6	4.8	1.26
8120	30	20.8	1.45*	12	8.3	1.45
8121	38	31.1	1.22	16	12.3	1.30
Total	106	100.3	1.06	50	43.3	1.15

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

* Significantly different from 1.0, $p < 0.05$

Table 42. Observed and expected incidence of cancer in 1982-84 among the residents of census tracts surrounding James River Graphics plant, and SIRs

Cancer	Male cases			Female cases		
	Obs.	Exp.	SIR	Obs.	Exp.	SIR
Lung	32	29.8	1.07	20	16.1	1.24
Urinary Bladder	14	8.5	1.64	6	4.2	1.43
Leukemia	1	1.5	0.65	0	-	-
Prostate	27	26.5	1.02			
Breast				34	44.5	0.76
Reproductive organs				21	21.3	0.99

Expected incidence based on sex-specific incidence in Massachusetts, adjusted for age

Table 43. Smoking Status at the time of Diagnosis of Cancer Cases who were Residents of South Hadley

Smoking Status	Bladder Cancer				Lung Cancer				Colon/Rectal Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Current Smoker	3	(30.0)	0	-	3	(72.2)	9	(56.2)	4	(22.2)	3	(15.8)
Ex-Smoker	0	-	1	(100.0)	5	(27.8)	4	(25.0)	4	(22.2)	3	(15.8)
Never Smoked	4	(40.0)	0	-	0	-	2	(12.5)	5	(27.8)	11	(57.9)
Unknown	3	(30.0)	0	-	0	-	1	(6.2)	5	(27.8)	2	(10.5)
Total	10	(100.0)	1	(100.0)	18	(100.0)	16	(100.0)	18	(100.0)	19	(100.0)

Source: Massachusetts Cancer Registry

Table 44. Smoking Status at the time of Diagnosis of Cancer Cases who were Residents of Chicopee

Smoking Status	Bladder Cancer				Lung Cancer				Colon/Rectal Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Current Smoker	4	(11.4)	1	(11.1)	42	(58.3)	22	(52.4)	17	(25.8)	10	(16.9)
Ex-Smoker	5	(14.3)	2	(22.2)	18	(25.0)	9	(21.4)	4	(6.1)	2	(3.4)
Never Smoked	7	(20.0)	5	(55.5)	4	(5.6)	5	(11.9)	22	(33.3)	24	(40.7)
Unknown	19	(54.3)	1	(11.1)	8	(11.1)	6	(14.3)	23	(34.8)	23	(39.0)
Total	35	(100.0)	9	(100.0)	72	(100.0)	42	(100.0)	66	(100.0)	59	(100.0)

Source: Massachusetts Cancer Registry

Table 45. Smoking Status at the time of Diagnosis of Cancer Cases who were Residents of Holyoke

Smoking Status	Bladder Cancer				Lung Cancer				Colon/Rectal Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Current Smoker	4	(19.0)	8	(50.0)	46	(69.7)	20	(54.1)	15	(23.8)	7	(11.1)
Ex-Smoker	2	(9.5)	0	-	16	(24.2)	7	(18.9)	7	(11.1)	4	(6.3)
Never Smoked	5	(23.8)	4	(25.0)	2	(3.0)	2	(5.4)	16	(25.4)	32	(50.8)
Unknown	10	(47.6)	4	(25.0)	2	(3.0)	8	(21.6)	25	(39.7)	20	(31.9)
Total	21	(100.0)	16	(100.0)	66	(100.0)	37	(100.0)	63	(100.0)	63	(100.0)

Source: Massachusetts Cancer Registry

Table 46. Smoking Status of the Residents of South Hadley in 1986

Smoking Status	Male		Female		Total	
	#	(%)	#	(%)	#	(%)
Current Smoker	1	(50.0)	0	-	1	(50.0)
Ex-Smoker	1	(50.0)	0	-	1	(50.0)
Never Smoked	0	-	0	-	0	-
Unknown	0	-	0	-	0	-
Total Interviewed	2	(100.0)	0	-	2	(100.0)

Source: Massachusetts Health Interview Survey, 1986

Table 47. Smoking Status of the Residents of Chicopee in 1986

Smoking Status	Male		Female		Total	
	#	(%)	#	(%)	#	(%)
Current Smoker	8	(40.0)	5	(20.0)	13	(28.9)
Ex-Smoker	4	(20.0)	11	(44.0)	15	(33.3)
Never Smoked	8	(40.0)	9	(36.0)	17	(37.8)
Unknown	0	-	0	-	0	-
Total Interviewed	20	(100.0)	25	(100.0)	45	(100.0)

Source: Massachusetts Health Interview Survey, 1986

Table 48. Smoking Status of the Residents of Holyoke in 1986

Smoking Status	Male		Female		Total	
	#	(%)	#	(%)	#	(%)
Current Smoker	4	(44.4)	5	(41.7)	9	(42.9)
Ex-Smoker	1	(11.1)	1	(8.3)	2	(9.5)
Never Smoked	4	(44.4)	6	(50.0)	10	(47.6)
Unknown	0	-	0	-	0	-
Total Interviewed	9	(100.0)	12	(100.0)	21	(100.0)

Source: Massachusetts Health Interview Survey, 1986

Table 49. Smoking Status of the Residents of Massachusetts in 1986

Smoking Status	Male		Female		Total	
	#	(%)	#	(%)	#	(%)
Current Smoker	508	(29.9)	552	(27.1)	1060	(28.4)
Ex-Smoker	494	(29.1)	507	(24.9)	1001	(26.8)
Never Smoked	696	(41.0)	975	(47.9)	1671	(44.8)
Unknown	0	-	1	(0.0)	1	(0.0)
Total Interviewed	1698	(100.0)	2035	(100.0)	3733	(100.0)

Source: Massachusetts Health Interview Survey, 1986

Table 50. Usual Industry of Occupation of Cancer Incident Cases who were Residents of South Hadley

Industry Category	Colon/Rectal Cancer				Bladder Cancer				Lung Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Manufacturing												
Paper & Allied Products	0	-	0	-	1	(10.0)	0	-	1	(5.6)	0	-
Chemical	1	(5.6)	0	-	0	-	0	-	1	(5.6)	0	-
Rubber & Plastic Products	1	(5.6)	0	-	0	-	0	-	0	-	1	(6.2)
Metal Industries	0	-	0	-	0	-	0	-	1	(5.6)	0	-
Machinery	3	(16.7)	0	-	1	(10.0)	0	-	0	-	0	-
Other	2	(11.1)	0	-	2	(20.0)	0	-	3	(16.7)	0	-
Transportation & Communication	1	(5.6)	0	-	0	-	0	-	2	(11.1)	0	-
Sales	0	-	0	-	2	(20.0)	0	-	2	(11.1)	1	(6.2)
Professional & Personal Services	1	(5.6)	1	(5.3)	1	(10.0)	0	-	2	(11.1)	1	(6.2)
Other	0	-	0	-	0	-	1	(100.0)	0	-	0	-
Unknown	9	(50.0)	18	(94.7)	3	(30.0)	0	-	6	(33.3)	13	(81.2)
Total	18	(100.0)	19	(100.0)	10	(100.0)	1	(100.0)	18	(100.0)	16	(100.0)

Source: Massachusetts Cancer Registry

Table 51. Usual Industry of Occupation of Cancer Incident Cases who were Residents of Chicopee

Industry Category	Colon/Rectal Cancer				Bladder Cancer				Lung Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Manufacturing												
Paper & Allied Products	2	(3.0)	1	(1.7)	1	(2.9)	0	-	2	(2.8)	2	(4.8)
Chemical	2	(3.0)	0	-	1	(2.9)	0	-	1	(1.4)	0	-
Rubber & Plastic Products	3	(4.5)	0	-	1	(2.9)	1	(11.1)	2	(2.8)	0	-
Metal Industries	4	(6.1)	2	(3.4)	1	(2.9)	0	-	7	(9.7)	1	(2.4)
Machinery	5	(7.6)	1	(1.7)	5	(14.3)	0	-	7	(9.7)	0	-
Other	4	(6.1)	1	(1.7)	2	(5.7)	0	-	3	(4.2)	3	(7.1)
Transportation & Communication	3	(4.5)	0	-	0	-	0	-	3	(4.2)	0	-
Sales	3	(4.5)	4	(6.8)	1	(2.9)	0	-	4	(5.6)	0	-
Professional & Personal Services	3	(4.5)	2	(3.4)	6	(17.1)	2	(22.2)	3	(4.2)	4	(9.5)
Others	1	(1.5)	0	-	1	(2.9)	0	-	2	(2.8)	0	-
Unknown	36	(54.5)	48	(81.4)	16	(45.7)	6	(66.7)	38	(52.8)	32	(76.2)
Total	66	(100.0)	59	(100.0)	35	(100.0)	9	(100.0)	72	(100.0)	42	(100.0)

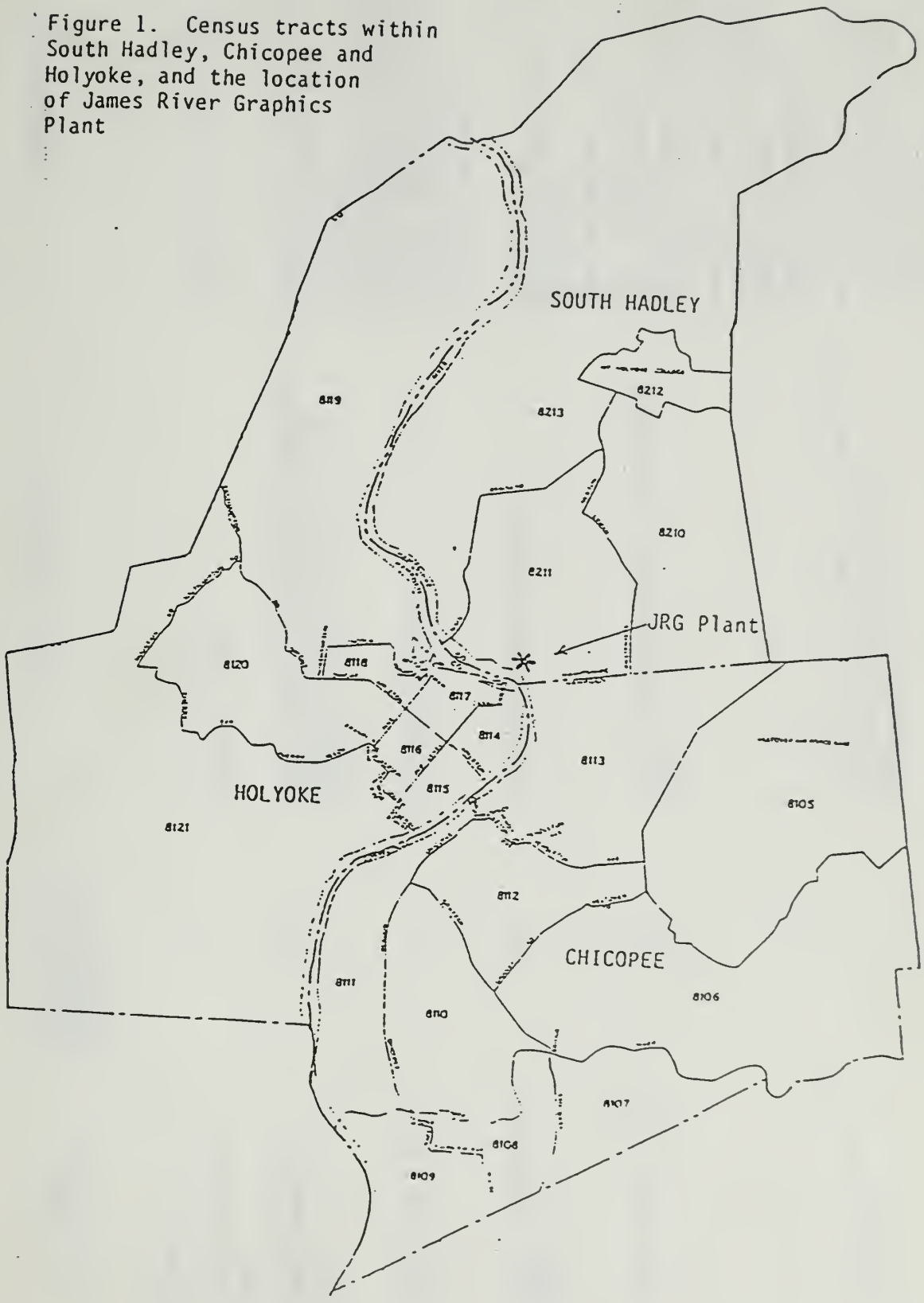
Source: Massachusetts Cancer Registry

Table 52. Usual Industry of Occupation of Cancer Incident Cases who were Residents of Holyoke

Industry Category	Colon/Rectal Cancer				Bladder Cancer				Lung Cancer			
	Male		Female		Male		Female		Male		Female	
	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)	#	(%)
Manufacturing												
Paper & Allied Products	2	(3.2)	2	(3.2)	1	(4.8)	3	(4.5)	1	(2.7)	2	(4.8)
Chemical	1	(1.6)	0	-	1	(4.8)	0	-	0	-	0	-
Rubber & Plastic Products	2	(3.2)	0	-	1	(4.8)	4	(6.1)	0	-	0	-
Metal Industries	0	-	2	(3.2)	1	(4.8)	7	(10.6)	0	-	1	(2.4)
Machinery	6	(9.5)	1	(1.6)	1	(4.8)	3	(4.5)	0	-	0	-
Other	4	(6.3)	0	-	0	-	5	(7.6)	1	(2.7)	3	(7.1)
Transportation & Communication	1	(1.6)	0	-	0	-	4	(6.1)	0	-	0	-
Sales	4	(6.3)	3	(4.8)	3	(14.3)	7	(10.6)	1	(2.7)	0	-
Professional & Personal Services	8	(12.7)	7	(11.1)	4	(19.0)	9	(13.6)	9	(24.3)	4	(9.5)
Others	2	(3.2)	0	-	1	(4.8)	3	(4.5)	0	-	0	-
Unknown	33	(52.4)	48	(76.2)	8	(38.1)	21	(31.8)	25	(67.6)	32	(76.2)
Total	63	(100.0)	63	(100.0)	21	(100.0)	66	(100.0)	37	(100.0)	42	(100.0)

Source: Massachusetts Cancer Registry

Figure 1. Census tracts within South Hadley, Chicopee and Holyoke, and the location of James River Graphics Plant



APPENDIX A

Current industries in South Hadley, Chicopee and Holyoke emitting volatile organic compounds (VOC)

SOURCE SIC CODE (1)	MOST RECENT VOC EMISSIONS (TONS PER YEAR)	TYPE OF OPERATIONS	OTHER COMMENTS
Holyoke:			
Holyoke/Power M. Tom	13	oil/power plant	-operating in 1943, 1970, currently
Hazen Paper Co. (2641)	104	paper coating, printing, lamination, decorative packaging papers and boards	-operating in 1943, 1970, currently -historical data: 1981 - emitted 423 tons VOC -1985 emissions - ethyl acetate, toluene, MEK, and cellosolve
Graph Coat, Inc.	15	coat metal parts	-organic solvents and thinners - not in operation in 1943, 1970, operating currently
Hampden Papers Inc (2641)	222	variety of paper coating	-operating in 1943, 1970, currently -historical data: 1983 - emitted 395 tons VOC -1985 emissions - ethyl acetate, MEK, toluene, MIBK
XIDEX Corp. (2641)	459	coats polyester film to microfiche film	-not in operation in 1943, 1970 -historical data - 1982 - emitted 1041 tons VOCs; 1983 - emitted 1189 tons VOCs; 1984 - emitted 1156 tons VOCs; 1985 - plant closed -1985 emissions - MEK, acetone, ethanol, isopropanol, isopropylacetate
Dennison National Co (2872)	48	notebooks, index tabs, and reinforced strips; spray paint, vapor degreasing, printing	-not in operation in 1943, 1970, and operating currently -historical data - 1980 - emitted 57 tons VOCs -1985 emissions - 1,1,1-trichloroethylene*, toluene, ethanol, isopropanol

Dielectric Polymers	40	paper coating	-not in operation 1943, 1970, and operating currently -1985 emissions - toluene, ethanol, isopropanol, MEK
Advance Offset Plate	42	metal parts fabricator	-not in operation 1943, 1970, and currently in operation -1985 emssions - organic solvents
Walter Drake, Inc. (2641)	19	printing, paper coating, blister packs	-not in operation 1943, 1970 -historical data - 1983 - 42 tons VOCs; 1986 - ceased operations -1985 emissions - naptha, MEK, toluene
Atlas Copco (3563)		air compressors, spray painting	-not in operation 1943, 1970 -historical data - 1975 - emitted 100 tons VOCs; 1979 - emitted 22 tons VOCs; 1981 - emitted 16 tons VOCs; 1984 - closed
Ludlow Corp. (2651)		paper coating, flexible packaging	-not in operation 1943, 1970 -historical data - 1981 - 143 tons VOCs; 1982 - 83 tons VOCs; burned down 1985
South Hadley:			
Texon, Inc. (2621)	93	man-made inner soles, printing	-not in operation 1943, in operation 1970 -historical data: 1981 - formaldehyde* 29 tons; phenol 144 tons; 1985 - formaldehyde* 78 tons, phenol 15 tons; misc. solvents and thinners; 1986 - plant closed
James River Graphics (2641)	2589	paper coating, films, recording equipment, microfilms, coated papers	-not in operation 1943, 1970, and currently in operation -historical data: 1980 - 10,657 tons VOCs; 1984 - 3972 tons; -1985 - emitted toluene, acetone, ethanol, methanol, ethyl acetate, butyl acetate, MEK, n-butanol, isopropanol, methyl cellusolve, MIBK, hexane, heptane, xylene, methyl cellusolve acetate, dimethyl formamide

Chicopee:

Spaulding Sports (3949)	123	golf balls and clubs, inflated balls	-in operation 1943, 1970, and currently in operation -historical data: 1984 - 167 tons VOCs -1985 emitted mineral spirits, toluene, xylene, naphtha, acetone, butyl acetate, butanol, carbitol, cellusolve, ethyl acetate, ethanol, isopropanol, methanol, MEK
Eastern Etching and Mfg. (3479)	45	metal nameplates, degreasing, surface coating	-in operation 1943, 1970, and currently in operation -historical data: 1985 - emitted 71 tons VOCs -1985 - emitted isopropanol, MEK, mineral spirits, varnish, shellac, thinners
McKinstry Metalworks (3444)	-	electrical outlets and distribution containers, primer and enamel paint spraying	-not in operation 1943, 1970, and currently in operation -historical data: 1980 - 18 tons
Servus Rubber Company (3079)	-	Montgomery Street Plant - rubber and vinyl footwear Coburn Street Plant - glued insoles	-Montgomery Street Plant historical data: 1979 - 466 tons - not in operation 1943, 1970, and currently in operation -Coburn Street Plant historical data: 1979 - 63 tons; 1981 - plant closed - not in operation 1943, 1970
Champion Intntl. Corp (2651)	-	print and varnish designs on cardboard	-not in operation 1943, 1970, and currently in operation -historical data: 1982 - 61 tons

1 - Standard Industrial Codes
2 - DEQE Source Inventory
* - Designated Carcinogen from the Massachusetts Substance List

APPENDIX B

PRINCIPAL MANUFACTURING INDUSTRIES IN 1943

Holyoke

Printers and Publishers	(27)
Books and Bookbinding	(3)
Box Manufacturing	(8)
Chemical Manufacturing and Supplies (paper chemicals)	(3)
Glue Manufacturing	(1)
Machinery Manufacturing	(6)
Paper Manufacturing	(27)
Rubber Goods Manufacturing	(1)
Textile Finishing	(1)
Wire and Wire Cloth Manufacturing	(5)

South Hadley

Paper Manufacturing	(4)

Chicopee

Paper Box Manufacturing	(2)
Lithography	(1)
Paper Manufacturing	(1)
Machinery Manufacturing	(2)
Publishing and Printing	(6)
Rendering Works	(1)
Rubber Goods Manufacturing	(2)
Screw Machine Products	(1)
Smelting and Refining	(1)
Tool Manufacturing	(4)

PRINCIPAL MANUFACTURING INDUSTRIES IN 1970

Holyoke

Asbestos Manufacturing and Products	(1)
Books and Bookbinding	(3)
Paper Box Manufacturing	(6)
Chemical Manufacturing	(2)
Diazo and Blueprinting	(2)
Epoxy Lacquer and Enamel Coatings and Finishings	(1)
Machinery Manufacturing	(4)
Synthetic Leather Manufacturing	(2)
Name Plate Manufacturing	(1)
Paper and Paper Products Manufacturing and Supplies	(24)
Plastics and Plastic Product Manufacturing	(4)
Printers and Typesetters	(16)
Rayon Manufacturing	(3)
Rubber Goods Manufacturing	(3)
Manufacture of Wire Products; Iron, Steel and Foundries	(8)

South Hadley

Synthetic Leather Manufacturing	(1)
Lithographic Plate Graining	(1)
Machinery and Tool Manufacturing	(3)
Paper and Paper Product Manufacturing	(8)
Plastic Coating and Fiber Manufacturing	(2)
Printers	(2)
Wire Manufacturing	(1)

Chicopee

Books and Bookbinding	(1)
Paper Box Manufacturing	(3)
Chemical Manufacturing	(3)
Diazo and Blueprinting	(1)
Machinery Manufacturing	(4)
Plastics and Plastic Product Manufacturing	(2)
Rubber Goods Manufacturing	(2)
Manufacture of Wire Products; Iron, Steel and Foundries	(5)
Lithographic Plate Graining	(1)
Paint Products	(1)

APPENDIX C

A PLANNED APPROACH TO COMMUNITY HEALTH (PATCH):

THE PREVENTION AND CONTROL OF CANCERS RELATED TO LIFESTYLE RISK FACTORS

February 1987

Massachusetts Department of Public Health

PURPOSE

The Massachusetts Department of Public Health (MDPH) will collaborate with the local health agency, local community workers, health professionals and citizens to form an active partnership with the purpose of developing health promotion programs designed to meet the priority health needs of the community. The major focus of these interventions will be to reduce the lifestyle risk factors associated with cancer.

RATIONALE

Given the overwhelming interest in health protection and health promotion among community groups from S. Hadley, Chicopee, and Holyoke, community involvement is necessary to ensure a successful intervention program. Incidence and mortality data will provide baseline data for developing health promotion programs. The availability of screening procedures for various cancers will be emphasized with the lay citizen and health professionals. State-of-the-art treatment techniques will be made available to community residents and health professionals. The target population for the PATCH program will be all adult residents (18 years +) of the communities of S. Hadley, Chicopee, and Holyoke.

OBJECTIVES

The PATCH program will provide the following services between July 1 and June 30, 1988:

1. Provide educational information on smoking, excess dietary fat/cholesterol, and excess alcohol consumption and their relationship to cancer to area residents.

2. Provide educational information on the necessity and availability of screening services for the early detection and treatment of cancer to area residents.

3. Provide educational information on the state-of-the-art treatment techniques for cancer to area residents.

4. Provide referrals to area residents for classes which focus on smoking cessation, alcohol modification, and nutrition counseling.

5. Provide professional educational programs to primary care providers in the areas of S. Hadley, Holyoke and Chicopee. Programs would focus on primary, secondary and tertiary treatment recommendations for the prevention and control of cancers related to modifiable risk factors.

METHODOLOGY

Community Orientation

The communities of S. Hadley, Holyoke and Chicopee will establish community groups to promote the health protection and health promotion programs developed by the PATCH initiative. Area community health centers, local health agencies and acute care hospitals will be contacted and asked to participate in the development and implementation of the PATCH intervention programs. This group of health professionals will identify the community's concerns, needs, resources and perceived health programs.

The PATCH Initiative

The PATCH initiative in these communities will focus on providing education

regarding the modifiable risk factors for cancer. The education component will target smoking, nutrition and alcohol as lifestyle risk factors which can be modified.

Each community will identify existing health care facilities where screening for cancer is available. Information regarding the community resources for treatment of cancer at these facilities will also be made available to the community.

Classes

Risk reduction classes for smoking, nutrition and alcohol will be developed and offered in these communities. Classes will be free to area residents.

Professional education programs will be coordinated through existing health care agencies. These programs will focus on preventive measures for cancers.

Resources

A PATCH program coordinator will be hired by the MDPH to have the lead responsibility for organizing, developing, implementing and evaluating the PATCH initiatives. The Northeast and Central Regional Health Promotion Councils already developed by the MDPH will serve as a vital resource in quickly developing the PATCH core group of community leaders.

All MDPH materials on smoking, nutrition and alcohol will be used accordingly.

Additionally, appropriate materials from the Massachusetts Nutrition Resource Center and the state's voluntary associations, including the American Cancer Society and the American Lung Association, will be made available.

EVALUATION

Evaluation will be a fundamental component of the PATCH program. Both process and impact outcomes will be evaluated. Pre/post assessments of knowledge and behavior changes will be part of the risk reduction programs for lay citizens. The seminars/programs for health professionals will also be evaluated for changes in knowledge of risk factors, screening applications, treatment regimens and interventions available to combat cancer.

For participants in the risk reduction classes, pre/post changes in dietary habits/cholesterol level, smoking status, and alcohol consumption will be assessed.

SUMMARY

We anticipate that the PATCH program will directly impact area residents of the communities of S. Hadley, Chicopee, and Holyoke. Preventive health information regarding smoking, nutrition, and alcohol consumption and their relationship to cancer will be made available to these communities through the PATCH program. The need for early detection via screening and state-of-the-art cancer treatment regimens will be part of the educational program for lay citizens and health professionals.

Risk reduction classes to modify smoking habits, dietary patterns and alcohol consumption will be made available to residents of these communities through the PATCH program. Professional education programs for these communities will focus efforts on educating the primary care physician. These professional programs will compliment the community approach of educating the consumer on health protection and health promotion.

APPENDIX D

Summary of Cancer Incidence and Mortality found to be in excess of the expected frequency among the Residents of Chicopee, Holyoke, and South Hadley and the James River Graphics Co. Census Tract Area*

Town	Sex	Cancer	Measure of Risk	Time Period
Chicopee				
	Males	bladder**	mortality	1980-1985
		bladder	incidence	1982-1984
		leukemia	mortality	1980-1985
		lung	mortality	1969-1985
	Females	bladder	mortality	1980-1985
Holyoke				
	Males	prostate	mortality	1969-1985
	Females	bladder**	incidence	1982-1984
South Hadley				
	Males	bladder	mortality	1969-1974
		bladder**	incidence	1982-1984
		prostate	mortality	1969-1985
	Females	reproductive organs**	mortality	1980-1985
		reproductive organs	incidence	1982-1984
		leukemia	mortality	1975-1979
		lung**	incidence	1982-1984
JRG Tracts				
	Males	bladder**	incidence	1982-1984
		prostate	mortality	1969-1985
	Females	bladder	mortality	1969-1985
		bladder**	incidence	1982-1984

* JRG Tract Area = Census Tracts 8113, 8114, 8117, 8211

** excess not statistically significant